Name: Key

**Chemistry 129.02 Fall 2010**

**General Chemistry**

Examination #1:

Equations, constants and periodic table are provided.

You may use a calculator.

**Show all your work!**

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Bonus: _____/2

Total: _____/100

1. (17 pts.) Metal hydrides react with water to form hydrogen gas and the metal hydroxide. Consider the reaction of 5.63g $SrH_2$ with 4.80g $H_2O$.

a) Balance the chemical equation for this reaction. (2 pts.)

$$\_\_\_\_ SrH_{2(s)} + \underline{2}\ H_2O_{(l)} \rightarrow \_\_\_\_ Sr(OH)_{2(s)} + \underline{2}\ H_{2(g)}$$

b) How many **grams** of $H_2$ will be produced? Which is the limiting reactant? What is the theoretical yield? (12 pts.)

$$5.63\ g\ SrH_2 \left(\frac{1\ mol\ SrH_2}{89.64\ g\ SrH_2}\right)\left(\frac{2\ mol\ H_2}{1\ mol\ SrH_2}\right)\left(\frac{2.02\ g\ H_2}{1\ mol\ H_2}\right) = 0.254\ g\ H_2$$

$$4.80\ g\ H_2O \left(\frac{1\ mol\ H_2O}{18.02\ g\ H_2O}\right)\left(\frac{2\ mol\ H_2}{2\ mol\ H_2O}\right)\left(\frac{2.02\ g\ H_2}{1\ mol\ H_2}\right) = 0.538\ g\ H_2$$

Limiting Reactant: $SrH_2$

Theoretical Yield: $0.254\ g\ H_2$

c) If the actual yield is 0.129 g, what is the percent yield? (3 pts.)

$$\%\ yield = \frac{actual\ yield}{theoretical\ yield} \times 100 = \frac{0.129\ g\ H_2}{0.254\ g\ H_2} \times 100 = 50.8\%$$

2. (6 pts.) When an evacuated 63.8 mL glass bulb is filled with a gas at 22°C and 760 torr, the bulb gains 0.103g in mass. Is the gas $N_2$, Ne, or Ar?

$MM = \frac{mRT}{PV}$

$V = 0.0638\ L$

$T = 22°C + 273.15 = 295\ K$

$P = 760\ torr \left(\frac{1\ atm}{760\ torr}\right) = 1.0\ atm$

$MM = \frac{(0.103\ g)(0.0821\ \frac{L \cdot atm}{mol \cdot K})(295\ K)}{(1.0\ atm)(0.0638\ L)}$

$MM = 39\ \frac{g}{mol}$ The gas is Ar.

3. (10 pts) Cortisol, one of the major steroid hormones, has the following percent composition has a molar mass of 362.47 g/mol: C, 69.6%; H, 8.34%; O, 22.1%. Find its empirical and molecular formulas.

$69.6\ g\ C \left(\frac{1\ mol\ C}{12.01\ g\ C}\right) = 5.80\ mol\ C$

$8.34\ g\ H \left(\frac{1\ mol\ H}{1.01\ g\ H}\right) = 8.26\ mol\ H$

$22.1\ g\ O \left(\frac{1\ mol\ O}{16.00\ g\ O}\right) = 1.38\ mol$

$C_{\frac{5.80}{1.38}} H_{\frac{8.26}{1.38}} O_{\frac{1.38}{1.38}} \Rightarrow (C_{4.20} H_{5.99} O) \times 5 \Rightarrow C_{21} H_{30} O_5$

Empirical Formula

$n = \frac{\text{molar mass compound}}{\text{molar mass emp. formula}} = \frac{362.47\ g/mol}{362.51\ g/mol} = 1$

$(C_{21} H_{30} O_5) \times 1 \Rightarrow C_{21} H_{30} O_5$

molecular formula.

Empirical Formula: $C_{21}H_{30}O_5$

Molecular Formula: $C_{21}H_{30}O_5$

4. (4 pts.) In the Rutherford nuclear-atom model, _____.

   (a) neutrons and electrons reside in the nucleus
   (b) the heavy subatomic particles, protons and neutrons, reside outside the nucleus
   (c) the nucleus is positively charged and most of the mass resides in it
   (d) protons, neutrons, and electrons have essentially the same mass
   (e) mass is spread uniformly throughout the atom

5. (4 pts.) Which of these electron transitions corresponds to absorption of energy and which to emission?

   (a) n = 2 to n = 4 absorption
   (b) n = 3 to n = 1 emission
   (c) n = 5 to n = 2 emission
   (d) n = 3 to n = 4 absorption

6. (6 pts) The C–O bond in an organic compound absorbs radiation of wavelength 9600 nm. (a) What frequency(in $s^{-1}$) corresponds to that of wavelength? (b)What type of electromagnetic radiation is this?

(a) $\nu = \frac{c}{\lambda} = \frac{3.00 \times 10^{8}\ m/s}{9.6 \times 10^{-6}\ m}$

$9600\ nm \left(\frac{10^{-9}\ m}{1\ nm}\right) = 9.6 \times 10^{-6}\ m$

$\nu = 3.1 \times 10^{13}\ s^{-1}$

(b) Infrared Radiation

7. (11 pts.) Fill in the gaps in the following table. Each column may represent a neutral atom or an ion.

| Symbol | $^{79}_{35}Br^{1-}$ | $^{90}_{40}Zr$ | $^{85}_{37}Rb^{+}$ |
|---|---|---|---|
| Protons | 35 | 40 | 37 |
| Neutrons | 44 | 50 | 48 |
| Electrons | 36 | 40 | 36 |
| Mass Number | 79 | 90 | 85 |
| Charge | 1− | 0 | 1+ |

8. (4 pts.) The elements in groups 1A and 7A are all quite reactive. What is a major difference between them?

(a) Group 1A elements gain electrons in chemical reactions while group 7A elements lose electrons.
(b) Group 7A elements are nonmetals and group 1A elements are metalloids.
(c) Group 1A elements lose electrons in chemical reactions while group 7A elements gain electrons.
(d) Group 7A elements form 1+ cations and group 1A elements form 1- anions.

9. (12 pts.) Fill in the gaps in the following table.

| Name | Formula | Ionic or Covalent? |
|---|---|---|
| sulfur tetrachloride | $SCl_4$ | covalent |
| ammonium bromide | $NH_4Br$ | ionic |
| lead (IV) oxide | $PbO_2$ | ionic |
| $NaHCO_3$ | sodium bicarbonate | ionic |
| $AgNO_3$ | silver nitrate | ionic |
| nitrogen trioxide | $NO_3$ | covalent |

10. (6 pts) Using the periodic table as a reference, determine whether a bond between each of the following pairs of atoms is polar, nonpolar or ionic? Which is the most electronegative atom in each pair?

(a) F and F

nonpolar same atom, same electronegativity

(b) K and Cl

ionic Cl is more electronegative

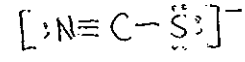
(c) P and O

polar O is more electronegative

11. (8 pts) The thiocyanate ion ($NCS^-$) has three possible Lewis structures.

(a) Draw these three Lewis structures, and assign formal charges to the atoms in each structure.

A

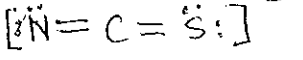


N: 5-2-3 = 0

C: 4-0-4 = 0

S: 6-6-1 = -1

B

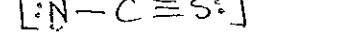


N: 5-4-2 = -1

C: 4-0-4 = 0

S: 6-4-2 = 0

C

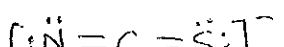


N: 5-6-1 = -2

C: 4-0-4 = 0

S: 6-2-3 = +1

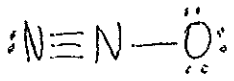
(b) Which Lewis structure is the preferred one? Why?



We eliminate form C because it has larger formal charges than the others and a positive formal charge on the more electronegative atom. Forms A & B have the same magnitude of formal charges, but form B has a -1 charge on nitrogen, which is more electronegative than sulfur. Therefore, B is the preferred one.

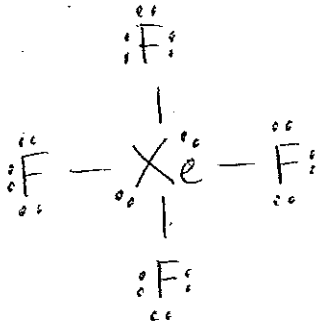
12. (12 pts.) Consider the following molecules: **$N_2O$ , $XeF_4$ , $SCl_4$.** (i) Draw their Lewis structure, (ii) Determine the electron and molecular geometries, (iii) Is the molecule polar or nonpolar?

(a) $N_2O$



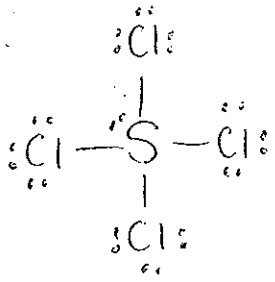
Electron Domain Geometry: linear
Molecular Geometry: linear
Polar or Nonpolar?: polar

(b) $XeF_4$



Electron Domain Geometry: Octahedral
Molecular Geometry: Square Planar
Polar or Nonpolar?: nonpolar

(c) $SCl_4$



Electron Domain Geometry: Trigonal Bipyramidal
Molecular Geometry: See Saw
Polar or Nonpolar?: polar